Appl. No.: 10/806,501
Amdt. dated 12/22/2004
Amdt. responsive to Office action mailed 09/14/2004

REMARKS/ARGUMENTS

1. Status of the Claims

In the Office Action mailed September 14, 2004, the Examiner noted that Claims 1-19 were pending in the Application. Claims 16-19 were withdrawn from consideration as a result of their being non-elected following a restriction requirement. Claims 5, 11, and 14 were found objectionable due to various informalities recited in those Claims. Claims 1, 3-5, and 13 were rejected under 35 U.S.C. 102(e) based on the Mathur patent (U.S. Patent No. 5,625,552). Claims 2 was rejected under 35 U.S.C. 103(a) based on the Mathur patent, and Claims 6, 11, 12, 14, 15 were rejected under 35 U.S.C. 103(a) based on the Mathur patent combined with Gold et al. (U.S. Patent No. 5,213,282).

By the present Amendment, Claims 5, 11, and 14 have been amended as necessary to overcome the objection to these Claims. Claims 1-6 and 11-15 have been amended as necessary to overcome the rejection of these Claims under 35 U.S.C. 102(e)/103(a). In addition, the rejections under 35 U.S.C. 103(a) are respectfully traversed due to lack of motivation to combine the Mathur and Gold patents, and the fact that such patents "teach away" from the invention as now claimed. Claims 16-19 have been canceled following the restriction requirement, and new Claims 20-25 have been added to the subject application to provide a varying scope of claim coverage. Accordingly, Claims 1-15 and 20-25 are pending in the subject application.

The following amendments and remarks are respectfully submitted.

2. Election/Restrictions

On Page 2, Item 2 of the Office Action, the Examiner reiterated the restriction requirement between Group I directed to Claims 1-15 and Group II directed to Claims 16-19. Applicant hereby confirms the election without traverse of Claims 1-15 for prosecution in this application, and hereby cancels Claims 16-19 consistent with this election.

3. Claim Objections

On Page 3, Item 3 of the Office Action, Claims 5, 11, 14 were found objectionable due to various informalities in their recitations. By the present Amendment, it is submitted that Claims 5, 11, 14 have been amended as necessary to overcome the objection to these Claims. Withdrawal of the objection is requested.

4. **Priority**

Applicant confirms the priority date of August 1, 1995 to U.S. Application No. 08/510,055 for all subject matter of pending Claims 1-15 and 20-25 with the exception of the subject matter included in new Claims 20-25 which was added in a continuation-in-part, U.S. Application No. 09/585,105, filed May 31, 2000, to which priority is also claimed for this application.

5. **Claims 1, 3-5 and 13 as amended are not anticipated under 35 U.S.C. 102(e) based on the Mathur patent (U.S. Patent No. 5,625,552)**

On Page 3, Item 5 of the Office Action, Claims 1, 3-5 and 13 were rejected under 35 U.S.C. 102(e) based on the Mathur patent. The Mathur patent and the reasons that Claims 1, 3-5 and 13 are patentable over the Mathur patent, are addressed in detail below.

a. The Mathur patent

The Mathur patent is directed to a closed loop neural network-based auto tuner 6 that generates proportional, integral, and/or derivative parameters K_C^*, K_I^*, K_D^* for a proportional-integral-derivative (PID) controller 5 based on previous values of these parameters K_C, K_I, K_D, the current values output u of the PID controller 5, and an output y of process 12 (Abstract, FIG. 1). The output of the PID controller 5 is provided to servomechanism 14 to control the process 12 (FIG. 1). Tuning of the parameters K_C^*, K_I^*, K_D^* is done empirically, on the basis of optimized values generated in the training phase (C4, L20-22). The neural network 6 must be trained off-line to identify the control parameters K_C^*, K_I^*, K_D^* (C4 L23-24) for a set of possible plant models (C4 L28-49).

A disadvantage of the Mathur patent's design is that it is very possible in practical implementations that the process 12 under control may not be a member of the set of possible plant models for which the neural network tuner 6 was trained. This frequently happens in situations in which the process under control is difficult to model, or in which there is a sudden change in the process dynamics, as would occur in the event of failure of one of the actuators used to control the process, for example. Thus, unlike the claimed invention, the Mathur patent can be used to control processes under very limited circumstances in which the process dynamics are well understood, and any major change in the process is due to a change in its set point.

b. Claims 1, 3-5 and 13 as amended are not anticipated by the Mathur patent

Claim 1 has been amended to recite "the neural network receiving the control signal as an input and using the output signal to modify the connection weights of the neural network **on-line as the neural network and linear controller are used to control the non-linear physical process**." This amendment does not introduce new matter because support for this limitation is found in the specification at Paragraphs [0007], [0008], [0011], [0012], [0025], [0026], [0036], [0037], [0041] - [0043], [0047], [0050], [0054], [0058], [0060], and Claim 4. The Mathur patent expressly contradicts this limitation of the claimed invention by requiring that training for its neural network tuner 6 be conducted off-line for a set of possible process models while not in use to control the process. The requirement for off-line training in the Mathur patent results in several disadvantages. For example, it is very possible that the process to be controlled does not conform to any model for which the tuner was trained. This circumstance frequently occurs because one may not be able to accurately model a process due to complexity of its dynamics, for example. In contrast, in Claim 1 as amended, the claimed computer system has the ability to control a process without requiring an accurate model for the process being controlled. This is because the connection weights of the neural network can be adapted on-line to effectively control the process regardless of the accuracy of any model under which the neural network was initially trained. In addition, under a sudden change in process dynamics, such as a failure of an actuator used to control the process or a failure of a sensor used to sense an output from the process, the Mathur patent's controller has no adaptive capability to respond to changes of this nature, resulting in ineffective control of the process. In contrast, because its neural network connection weights are adapted on-line, the computer system of Claim 1 has the capability to adapt to unknown (even unexpected) process dynamics. Thus, this limitation of Claim 1 as amended provides major advantages over the prior art.

In addition, Claim 1 recites "the neural network generating a modified control signal **that combines with the control signal output from** the linear controller." In contrast, in the Mathur patent, the proportional, integral, and/or derivative parameters K_C*, K_I*, K_D*output by the neural network tuner 6 are not combined with the output of the PID controller 5, but are instead used to replace its gain parameters K_C, K_I, K_D. Thus, in the Mathur patent, only the gain parameters K_C,

K_I, K_D of the PID controller can be modified to respond to a change in set point of the process. In contrast, by combining signals output by the neural network and the linear controller in Claim 1 as amended, the claimed invention is not strictly limited to control that can be accomplished by adjusting gain parameters of a PID controller. Thus, Claim 1 as amended further distinguishes over the Mathur patent for this additional reason.

Claims 3-5 and 13 depend from Claim 1 as amended and thus include all of the limitations of that Claim in addition to other limitations that are not disclosed in the prior art. For example, Claim 4 recites that the "neural network is trained entirely on-line based on the output signal (from the nonlinear physical process)." The Mathur patent expressly contradicts this limitation by stating "the neural network must be trained off-line to identify the control parameters." C4 L24-25. In addition, Claim 5 recites "the linear controller comprises a plurality of attitude controllers and the neural network comprises a plurality of neural network subunits, the attitude controllers and neural network subunits generating respective degrees of freedom of the modified control signal." Although the Mathur patent mentions in its Background that the altitude of an aircraft is one example of the output of a process (C1 L13-18), it mentions nothing about attitude controllers and neural network subunits generating respective degrees of freedom of a modified control signal. Accordingly, at least for these reasons as well as the reasons stated above with respect to Claim 1 as amended, Claims 3-5 and 13 patentably distinguish over the prior art.

6. Claim 2 is not obvious under 35 U.S.C. 103(a) in view of the Mathur patent

On Page 5, Item 7 of the Office Action, Claim 2 was rejected under 35 U.S.C. 103(a) based on the Mathur patent.

Claim 2 depends from Claim 1 as amended, and thus includes all of the limitations of that Claim as described in detail above with respect to Claim 1 as amended. Accordingly, for at least the reasons stated above with respect to Claim 1 as amended, Claim 2 would not have been obvious to a person of ordinary skill in the art at the time the invention was made.

7. **Claims 6 and 11-12 are not obvious under 35 U.S.C. 103(a) based on the Mathur patent in view of the Gold patent (U.S. Patent No. 5,213,282)**

On Page 5, Item 8 of the Office Action, Claims 6 and 11-12 were rejected under 35 U.S.C. 103(a) based on the Mathur patent in view of the Gold patent. The Mathur patent has been addressed previously in this Amendment. The Gold patent and the reasons that Claims 6 and 11-12 patentably distinguish over the prior art are addressed separately below.

a. The Gold patent

The Gold patent discloses a helicopter fly-by-wire control system that includes a model following control system to provide the pilot with maneuvering feel on a side arm controller for high banked turns as though the pilot were actually flying a helicopter with mechanical linkages (Abstract; Background C1 L13 – C2 L33). In addition, the helicopter flight control system 21 has automatic control features to permit the pilot to fly shallow banked coordinated turns without having to apply a nose up pitch command (Abstract).

As shown in FIG. 1 of the Gold patent, the helicopter flight control system 21 includes a Primary Flight Control System (PFCS) 22 and an Automatic Flight Control System (AFCS) 24 (C3 L52-54). The PFCS 22 receives displacement command output signals from a displacement collective stick 26 on line 27 and the AFCS 24 receives the collective stick discrete output signal on a line 28 (C3 L54-57). The PFCS 22 and the AFCS 24 each receive the force output command signals of a force type four axis sidearm controller 29, on lines 30, and the aircraft's sensed parameter signals from sensors 31, on lines 32 (C3 L57-61). The pilot command signal on lines 27, 28, and 30 and the sensed parameter signals on lines 32 are shown consolidated within trunk lines 33 and 34 in the PFCS and AFCS, respectively (C3 L61-64). The PFCS and the AFCS contain control logic for controlling the yaw, pitch, roll, and lift axes of the aircraft (C3 L65-67). The PFCS provides rotor command signals and the AFCS logic provides conditioning and/or trimming of the PFCS four axis logic functions (C4 L1-3). The PFCS and AFCS provides respective command signals to the main rotor and tail rotor via servos 46, 48, and linkages 47, 49 (C4 L5-13). The sensed parameter signals from the sensors 31 on lines 32 provide the PFCS and the AFCS with the aircraft's angular rate and attitude response to the rotor command signals (C4 L13-16).

b. Claims 6 and 11-12 are not obvious under 35 U.S.C. 103(a) based on the Mathur patent in combination with the Gold patent

There is no teaching or suggestion in either the Mathur patent or Gold patent, nor any knowledge available to a person of ordinary skill in the art, that would have led such person to combine the Mathur and Gold patents. More specifically, there is no teaching, suggestion or other motivation in either patent that directs one of ordinary skill in the art to combine the controller 11 of the Mathur patent with the flight control system 21 of the Gold patent in any way that could obtain the claimed invention. The motivation for combining the Mathur and Gold patents must be found in the prior art and not the Applicant's disclosure. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). In addition, the teaching, suggestion, or motivation to combine features in an effort to obtain the claimed invention must be "...clear and particular." *In re Dembiczak*, 175 F.3d 994, 999, 50 USPQ2d 1614, ____ (Fed. Cir. 1999). Otherwise, the motivation to combine the patents is found through impermissible hindsight in the Applicant's disclosure, in effect using what the Applicant taught in its disclosure against the Applicant. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

In addition, the Mathur patent "teaches away" from the claimed invention by requiring its neural network to be trained off-line to adjust gains of its PID controller 5. Hence, there is no motivation that would have led a person of ordinary skill in the art to combine the Mathur and Gold patents in an effort to obtain the invention as now claimed. In fact, a person of ordinary skill in the art would be led to conclude that the Mathur patent should not be used alone or in combination with any other reference to assert that the invention is unpatentable because its teachings are directly contradictory to the invention as now claimed.

Furthermore, Claims 6 and 11-12 depend from Claim 1 and include all of the limitations of that Claim. Whether considered alone or in combination, the Mathur and Gold patents fail to disclose the features noted above with respect to Claim 1 as amended. For example, the combination of the Mathur and Gold patents fails to disclose a "neural network receiving the control signal as an input and using the output signal (of the nonlinear physical process) to modify the connection weights of the neural network **on-line as the neural network and linear**

controller are used to control the non-linear physical process." In the Mathur patent, training of the neural network tuner 6 is performed strictly off-line while the tuner 6 and PID controller 5 are not being used to control a process. The Mathur patent's controller has no ability to control a process that is not included within the set of process models for which the PID controller was trained. In contrast, the computer system of Claim 1 as amended has the ability to adapt on-line in order to effectively control the non-linear physical process, and the initial training of the neural network (if any) need not be accurate. Accordingly, Claims 6 and 11-12 are patentable over the prior art for this reason.

In addition, Claim 1 as amended recites "the neural network generating a modified control signal **that combines with the control signal output from** the linear controller." In contrast, in the Mathur patent, the output of the neural network is used to adjust the gains of the PID controller 5, and is not combined with the output of such PID controller. Similarly, in the Gold patent, there is no disclosure of any signal generated by a neural network that is combined with a signal output from a linear controller. This feature of the invention enables the linear controller and neural network to control a process even if the process does not conform to a model for which the neural network was trained or in the event of a sudden change in process dynamics caused by an actuator failure, for example. Accordingly, it is submitted that Claims 6 and 11-12 are patentable over the prior art for at least the reasons stated above with respect to Claim 1 as amended.

In addition, Claims 6 and 11-12 recite other limitations which are not disclosed by the prior art. For example, Claim 11 as amended recites "an inverse function unit connected to receive **the combined** control signal **and modified control signal**, the inverse function unit generating **an actuator** control signal for controlling the non-linear physical process based on the **combined** control signal **and modified control signal**." The Mathur and Gold patents disclose no inverse function unit that receives the combination of a control signal from a linear controller and a modified control signal from a neural network. Thus, for this additional reason, Claims 6 and 11-12 would not have been obvious to a person of ordinary skill in the art. Accordingly, it is submitted that Claims 6 and 11-12 are patentable over the prior art.

8. Rejection of Claims 14-15 under 35 U.S.C. 103(a) based on the Mathur patent in view of the Gold patent

On Page 6, Item 9 of the Office Action, Claims 14-15 were rejected under 35 U.S.C. 103(a) based on the Mathur patent in view of the Gold patent.

For similar reasons to those stated above, the combination of the Mathur and Gold patents is respectfully traversed. In addition, by the present Amendment, Claim 14 has been amended to recite "**the neural network receiving at least the control signal as an input and using the measured output signal to modify the connection weights of the neural network on-line as the neural network and PD linear controller are used to control the physical process**." In contrast, the Mathur patent teaches that its neural network tuner 6 should be trained off-line while it is not being used to control a process 12 (C4 L23-24). The Gold patent fails to disclose any neural network at all. Accordingly, the combination of the Mathur patent and the Gold patent fails to disclose this limitation of Claim 14 which provides the advantage of being able to adapt to effectively control a process even for process models the linear controller was not designed to control. In addition, this limitation of Claim 14 makes it possible for the claimed computer system to maintain control of a process even under sudden changes in process dynamics, such as the failure of an actuator, for example. Thus, it is submitted that Claim 14 as amended is patentable over the prior art.

Claim 15 depends from Claim 14 and includes all of the limitations of that Claim plus additional limitations that are not disclosed by the prior art. For example, Claim 15 as amended recites "an inversion function unit coupled to receive the command signal, the measured output signal, the pseudo control signal, **and the modified pseudo control signal combined by** the node, the inversion function unit generating a control signal for controlling the non-linear physical process based on the command signal, the measured output signal, the pseudo control signal, **and the modified pseudo control signal combined by the node**. The Mathur patent fails to disclose any such inversion function unit. Likewise, although the Gold patent discloses an inverse model 56, it is not coupled to receive a combination of a command signal, measured output signal, pseudo control signal, and modified pseudo control signal from a node. Accordingly, the Mathur and Gold patents, whether considered alone or in combination, fail to

disclose the limitations of Claim 15. Thus, for this reason as well as for the reasons stated above with respect to Claim 14 as amended, it is submitted that Claim 15 as amended is patentable over the prior art.

9. New Claims

By the present Amendment, new Claims 20-25 have been added to the subject application. Claims 20-22 depend from Claim 1 and include all of the limitations of that Claim. Accordingly, for the reasons set forth above with respect to Claim 1, it is submitted that Claims 20-22 are patentable over the prior art. In addition, Claims 20-22 recite additional limitations that are not disclosed by the prior art. For example, Claim 20 recites that the combined signals from the linear controller and neural network are used to control a hydraulic actuator, and Claim 22 recites that the combined signals are used to control synthetic jets. None of these features are disclosed in the Mathur and Gold patents, whether considered alone or in combination. Similarly, Claims 23-25 depend from Claim 14 and include all of the limitations of that Claim plus additional limitations that are not disclosed by the prior art, including a hydraulic actuator (Claim 23) and synthetic jets (Claim 25) which are not disclosed in the Mathur and Gold patents, whether considered alone or in combination. Accordingly, for at least these reasons, it is submitted that Claims 20-25 are patentable over the prior art of record.

Conclusion

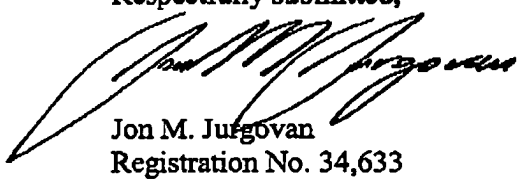
The election of Claims 1-15 without traverse is confirmed in response to the restriction requirement, and Claims 16-19 have thus been canceled. Also, it is submitted that Claims 5, 11, and 14 have been amended as necessary to overcome the objection to these Claims. Further, it is submitted that Claims 1-15 and new Claims 20-25 are patentable over the prior art. Reconsideration of Claims 1-15, consideration of new Claims 20-25, withdrawal of all objections and rejections, and a Notice of Allowance for all pending Claims, are requested.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required

Appl. No.: 10/806,501
Amdt. dated 12/22/2004
Amdt. responsive to Office action mailed 09/14/2004

therefore (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,



Jon M. Jurgovan
Registration No. 34,633

Customer No. 00826
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Atlanta Office (404) 881-7000
Fax Atlanta Office (404) 881-7777

CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that this paper is being facsimile transmitted to the US Patent and Trademark Office at Fax No. (703) 872-9306 on the date shown below.

Shelley Victoria — Date: 12-23-04

ATL01/11809401v1